

*Dynamics of Low Velocity Collisions of Ice Particle, Coated with Frost.*F. Bridges[†], D. Lin^{*}, L. Boone[†], D. Darknell[†][†]Physics Dept., University of California at Santa Cruz, Santa Cruz, CA^{*}Astronomy and Astrophysics Dept., University of California at Santa Cruz

We have continued our investigations of low velocity collisions of ice particles for velocities in the range $10^{-3} \text{ cm/s} < v < 2 \text{ cm/s}$. Our work this year focused on two efforts: 1) the sticking forces for ice particles coated with CO₂ frost, and 2) the completion of a 2-D pendulum system for glancing collisions. In addition, we revised our first paper on the sticking properties of water frost coated particles. This paper, published in 1991 has received considerable attention. The measured sticking forces for water frosts are of order 100 dynes. This is large enough to hold composite particles together in the tidal gravitational forces of Saturn, for clusters up to $\sim 10\text{m}$ in size. The fact that water frost provides a significant sticking force at low temperatures (100°K) provides a mechanism for the formation of larger particles via aggregation. We find that uncompacted frosts, for impact velocities in the range 0.2 mm/s - 0.8 mm/s give the largest sticking forces. Above a critical velocity (which varies with the frost layer) no sticking occurs and the frost becomes compacted after 8-10 collisions. At very low impact speeds, the particles will also stick but the force needed to separate them (i.e. the sticking force) is considerably smaller.

Our studies of sticking forces for CO₂ frost on the surfaces indicate very similar properties. The sticking forces are comparable, 2-20 dynes, and no sticking occurs for velocities greater than $\sim 1\text{mm/sec}$. This property may be a general feature of frosts and not strongly dependent on the composite of the frost at temperatures low enough that sublimation and/or melting are not important. Future studies are planned to investigate this hypothesis.

The majority of our effort has been directed toward the 2-D pendulum. The pendulum and control electronics are built and we have balanced it in a room temperature set up. Both rotation axes have low loss, with Q's greater than 10 at a period of 15 sec have been achieved. Balancing for the vertical axis of rotation is more difficult than the horizontal axis, and we are now developing electronic sensors to simplify this process. We have also developed new computer software to control and monitor the position of the 2-D pendulum.

We are now in the process of testing the pendulum and the computer control system in a series of room temperature experiments. In Fig. 1 we plot the vertical and horizontal position of a rubber super-ball attached to the 2-D pendulum. For these tests, the ball bounced on a very rough surface (sandpaper on a solid platform) to simulate a condition with a very large

horizontal sliding friction force - a worst case situation. The pendulum handles the resulting sideways torque well, although the damping for vertical motion increased. At the collision indicated by the arrow, the change in the magnitude of the vertical velocity component is small (~ 0.9) but the horizontal component of velocity decreased by about a factor of 3. In collisions on smooth surfaces with little friction, the change in horizontal speed can be very small.

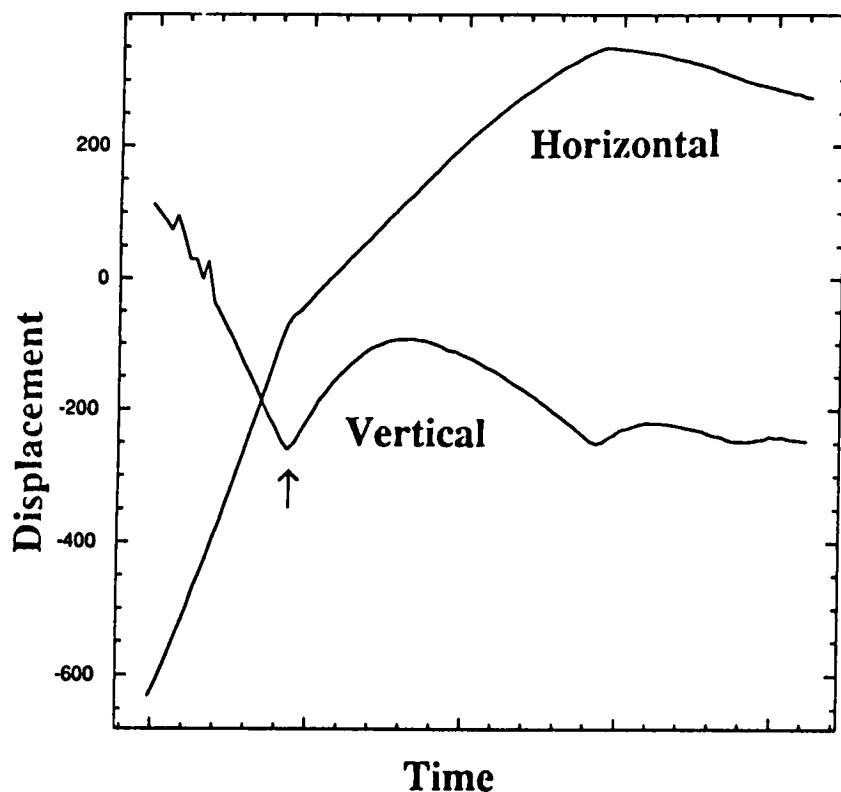


Fig. 1. The horizontal and vertical components of the displacement of the ball as a function of time. The arrow indicates the time of a collision.

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